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NASA TECH BRIEF

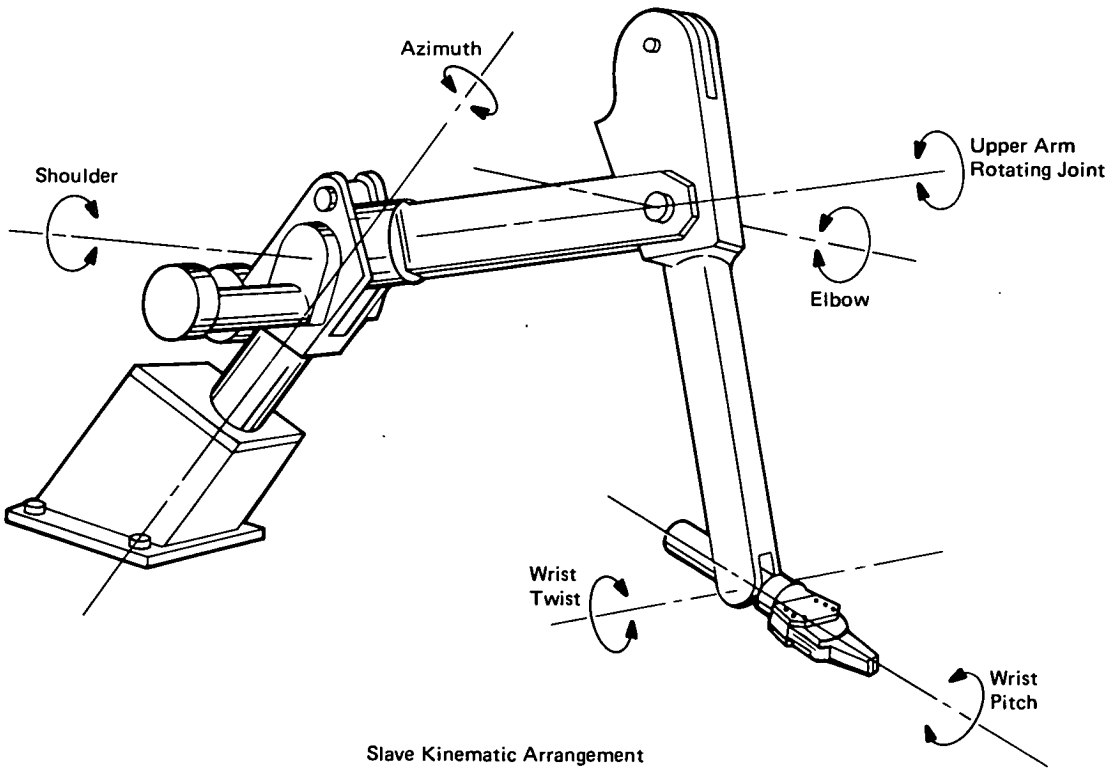
Marshall Space Flight Center

Advanced Action Manipulator System (ADAMS)

Hands and arms, man's most indispensable and versatile tools, are easily injured in hostile environments. For this reason, explosive, radioactive, etc., objects are sometimes handled with mechanical manipulators. A typical manipulator system is operated with hands and arms and should reproduce as closely as possible their agility, sensitivity, and freedom of motion. Unfortunately, most manipulators are very complex and expensive. Therefore, recent emphasis has been to cut their cost and complexity with a token compromise in performance.

One recently developed low-cost manipulator called the Advanced Action Manipulator System (ADAMS) offers improved performance over other models in its category. It features larger force and reach capabilities and is readily convertible for underwater use. The system, built as a unique kinematic arrangement, provides an extremely large working envelope. The arms are designed so that appropriate seals may be added for shallow, underwater operation. The system has six degrees of motion (see figure): the azimuth joint, the shoulder joint, the upper arm rotating joint, the elbow joint, the wrist pitch, and the wrist twist. Its other features include:

1. A load capacity of 6 lb (2.7 kg).
2. A slave arm positional accuracy of 0.1 in. (2.5 mm).
3. A reach capacity of 3.5 ft (1.05 m).
4. A maximum arm speed of 30 in/sec (0.75 m/sec).



Slave Kinematic Arrangement

(continued overleaf)

In addition, the arms are of conventional aluminum welded construction for light weight. Stainless steel is used where added strength is needed.

The drive mechanisms of the system are operated with electronic controls and employ permanent-magnet servo motors with attached planetary gearheads. One motor gearhead combination is used for the shoulder and elbow motion, the other is used for the wrist motion. The potentiometers are packaged internally for protection and to minimize the profile. They are spur-gear driven off the motor shaft.

Two main sets of counterweights are included with the system. They extend behind the shoulder approximately eight inches (20 cm). The sum of the two sets eliminates the shoulder joint imbalance. Adjustments of these counterweights between the right-hand and left-hand manipulators provide balance about the tilted azimuth axis.

The servo controls include an operational amplifier output stage to drive the motors. A power conditioning card feeds ± 8.1 V to the potentiometers and ± 6.2 V to the operational amplifier. In addition, a lag network within the amplifier provides the servo compensation. Finally, gain between the master and slave is controlled by a stepping rotary switch which changes the master input resistance to the operational amplifier.

Note:

Requests for further information may be directed to:

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Patent status:

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